Novel cryogen-free HTS magnets for beam-lines

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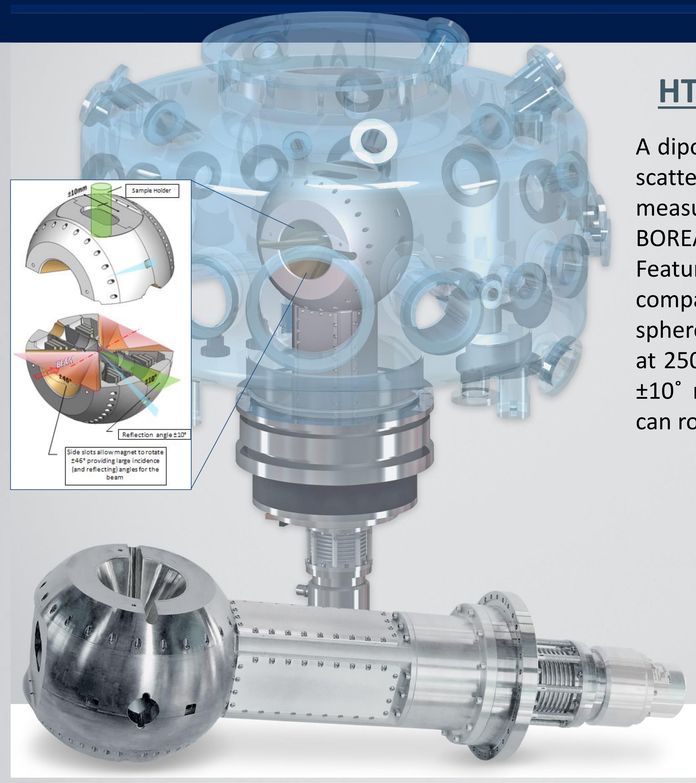
ABSTRACT

The novel HTS magnets described in this paper were designed, built and commissioned by HTS-110 for the world's leading synchrotron and neutron beam-lines. Our company has substantial experience in custom magnets, ranging from compact dipoles and vector magnets to large solenoids, with fields up to 8.5 T. All of these are conduction-cooled by closed-cycle GM or pulse-tube cryocoolers – providing cryogen-free operation with no cryogen costs, handling or safety requirements, and are supplied with remote monitoring hardware to protect them from quench.

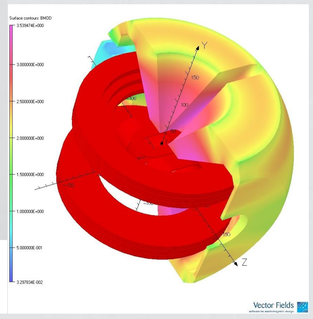
HTS magnets are especially suited to beam-line instruments where small size, low weight, complex geometries, and fast field ramping are often required. Highly customized UHV magnets have also been manufactured which can withstand a baking-out procedure with surface temperatures up to 120°C for several hours.

We work in partnership with our clients to identify the optimal solution for their magnets by remaining engaged throughout the entire design and manufacturing process. Manufacture and testing of prototype sub-assemblies at our company's facilities is followed by final product design, manufacturing and commissioning by HTS-110 staff at the clients' site.

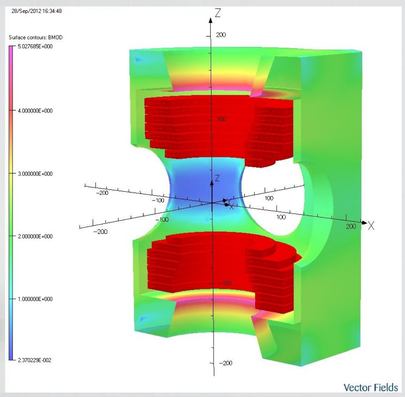


HTS Dipole Magnet

A dipole magnet for X-ray resonant scattering and absorption measurements built for the BOREAS beamline, **ALBA**, Spain. Features: 2T centre field in compact head (370 mm diameter sphere), low stray field (<50 Gauss at 250 mm), ±46˚ incidence angle, ±10˚ reflection angle. The magnet can rotate up to ±46˚.

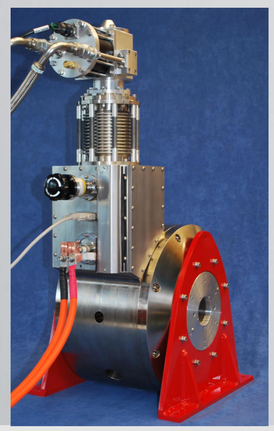


HTS Dipole Magnet for Neutron beam TOF scattering



Built for the Technische Universitaet Meunchen, Germany for installation in the Forschungsreactor Munchen II. This dipole was designed for neutron beam time of flight (TOF) scattering measurements. The magnet produces a 2T field within an 80 mm room-temperature bore, it is suitable for scattering angles up to 150˚ and can be tilted in any direction .

HTS Dipole Magnet for X-Ray Magnetic Circular Dichroism (XMCD) Experiments



This is a UHV-compatible dipole magnet designed and built for the National University of Singapore, for use in Magnetic X-ray Circular Dichromatism (XMCD) experiments at the Singapore Synchrotron Light Source. It produces fields up to 2.16 T across a 90 mm pole gap with field homogeneity better than 0.1% over a 1 cm diameter sphere. It has an independent bake-out system for the integrated XMCD UHV chamber with nine access ports allowing baking at 100 °C without affecting the HTS core.

HTS 5 Tesla Neutron Beamline Magnet

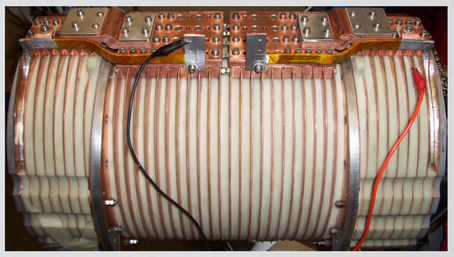
A 5 T split pair magnet, designed for both neutron reflectometry and small-angle neutron scattering research at the OPAL neutron facility of the Australian Nuclear Science and Technology Organisation. The magnet offers wide neutron beam accessibility angles of 16°-32° in both axial and transverse directions, large (50 mm) sample capability, and can be tilted up to 15° on a goniometer mounting stage operating in two axes. The magnet uses pulse-tube refrigeration for the HTS coils, which have been constructed from high performance BSCCO wire, and is compatible with a commercial cryo-furnaces providing sample temperatures from 4 K to over 600 K.

TATA Solenoid

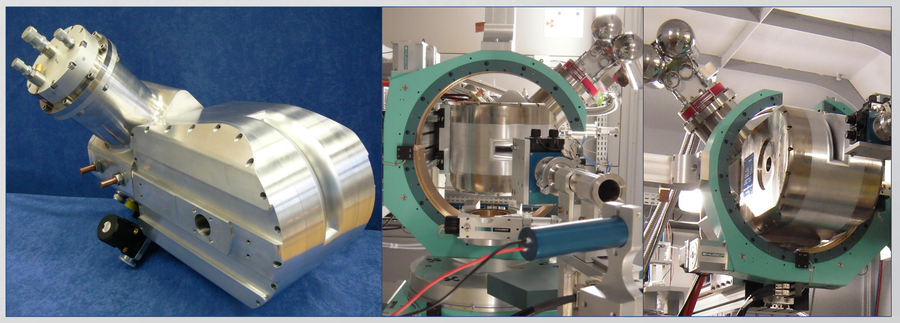
This solenoid magnet with an iron yoke was built for TATA Institute of Fundamental Research, India for ion beam focussing at the Pelletron LINAC Facility in Mumbai. The magnet has a UHV-compatible warm bore of 150 mm with flange-to-flange length of 650 mm and produced a peak field of 4.75 T and a field integral of 10.3 T^2m. Ramping time to full field was less than 15 minutes.

An external iron return/shield limited the 5 Gauss fringe field line to ~800 mm from the magnet surface.

Benefits: Reduced mass, significantly reduced flange-to-flange length, as well as reduced fringe fields compared with a copper solution.



6 Tesla Synchrotron Beamline Magnet



These magnets were designed for resonant magnetic scattering and high resolution x-ray diffraction, with field strength up to 6.4 T and a 120° scattering angle. They are sufficiently light and compact to be installed and rotated inside Eulerian cradles (Huber 512.5). They have 40 mm room temperature bores, compatible with variable temperature inserts and use low vibration, low maintenance cryogen-free cooling systems. Locations: Hemholtz Zentrum Berlin (HZB), Brazilian Synchrotron Light Source Laboratory (LNLS) and Darmstadt University of Technology(DUT).

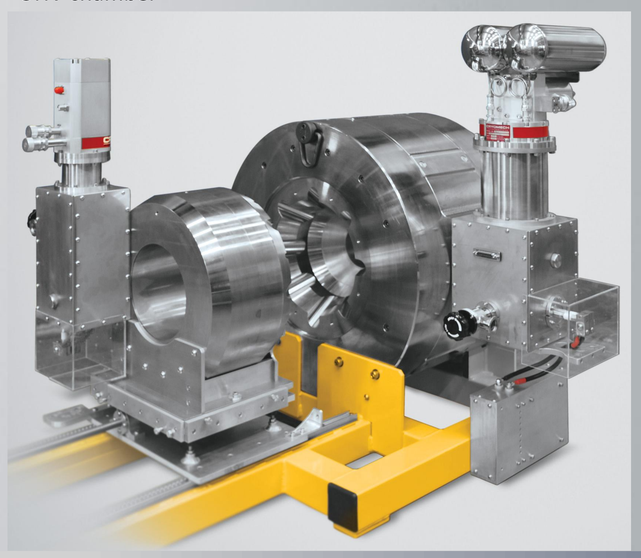
BNL Retrofit Dipole

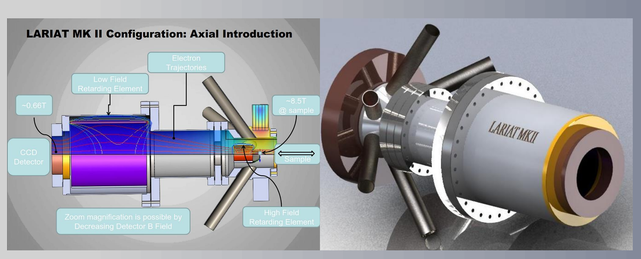
A copper coil dipole magnet from the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory (BNL) has been retrofitted with two double pancake coils of stainless-laminated BSSCO wire wound into a reverse-saggita shape. The magnet produced a field of 1.4 T across a 55 mm pole gap along a 1.5 m radius 45˚ arc. It achieved a reduction in operating power of 70%, and approximate doubling of the beam-extraction aperture as the HTS cryostats were significantly smaller than the copper coils.

TPS Retrofit Dipole was built for the National Synchrotron Radiation Research Centre, Taiwan. It produced a 1.191 T field across a 46 mm pole gap. The homogeneity of ±1.2x10^{-4} T (measured across the range ±20 mm transverse to beam path) was 30% better than in a copper-wound dipole.

SRI – LARIAT MKII HTS Magnet System

This magnet system consists of two magnets: 8.5 T Sample Magnet with the field region of a cylinder with Ø28mm 14 mm long and 0.6 T Detector Magnet with the field region of Ø90 mm. Both magnets are mounted on a common platform with the detector magnet support allowing the magnet to be moved away from the sample magnet for the distance necessary for the installation and/or removal of the UHV chamber





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